The documentation and process conversion measures necessary to comply with this revision shall be completed by 24 September 2016.

INCH-POUND

MIL-PRF-19500/664E
24 June 2016
SUPERSEDING
MIL-PRF-19500/664D
28 March 2012

PERFORMANCE SPECIFICATION SHEET

* TRANSISTOR, FIELD EFFECT, RADIATION HARDENED
N-CHANNEL, SILICON, ENCAPSULATED (SURFACE MOUNT AND CARRIER BOARD PACKAGES),
TYPES 2N7431, 2N7432, AND 2N7433, JANTXVR, F, G, AND H; AND JANSR, F, G, AND H

This specification is approved for use by all Departments and Agencies of the Department of Defense.

The requirements for acquiring the product described herein shall consist of this specification sheet and MIL-PRF-19500.

1. SCOPE

* 1.1 Scope. This specification covers the performance requirements for an N-channel, enhancement-mode, MOSFET, radiation hardened, power transistor. Two levels of product assurance (JANTXV and JANS) are provided for each encapsulated device with avalanche energy maximum rating (E_{AS}) and maximum avalanche current (I_{AS}). Provisions for radiation hardness assurance (RHA) to four radiation levels ("R", "F", "G" and "H") are provided for JANS and JANTXV product assurance levels. See 6.7 for JANHC and JANKC die versions.

* 1.2 Package outlines. The device package outlines are as follows: TO-276AC in accordance with figure 1, TO-276AC with lead option (U2L) in accordance with figure 2, and TO-276AC with carrier board option (U2S) in accordance with figure 3 for all encapsulated device types.

* 1.3 Maximum ratings. Unless otherwise specified, T_C = +25°C.

Type	P_T (1)	P_T T_A = +25°C (1)	$R_{\theta JC}$ (2)	$R_{\theta J}$ Carrier U2S	$R_{\theta J}$ Lid U2L (3)	V_{DS}	V_{DG}	V_{GS}	I_{D1} (4) (5)	I_{D2} T_C = +100°C (4)	I_S	I_{DM} (6)	T_J and T_{STG}
	W	W	°C/W	°C/W	°C/W	V dc	V dc	V dc	A dc	A dc	A dc	A(pk)	°C
2N7431U, U2L, U2S	300	2.5	0.42	1.5	10	60	60	±20	75.0	56.0	75.0	300	-55
2N7432U, U2L, U2S	300	2.5	0.42	1.5	10	100	100	±20	51.0	32.5	51.0	204	to
2N7433U, U2L, U2S	300	2.5	0.42	1.5	10	200	200	±20	43.0	27.0	43.0	172	+150

(1) Derate linearly by 2.4 W/°C for T_C > +25°C.
(2) See figure 4, thermal impedance curves.
* (3) The Thermal resistance is applicable for mounting methods where a heatsink is attached to the lid for U2L suffix devices.
(4) The following formula derives the maximum theoretical I_D limit. I_D is limited by package and internal construction.

$$I_D = \sqrt{\frac{T_{JM} - T_C}{(R_{\theta JC}) \times (R_{DS}(on) \text{ at } T_{JM})}}$$

(5) See figure 5, maximum drain current graph.
(6) I_{DM} = 4 X I_{D1} as calculated in note (3).

Comments, suggestions, or questions on this document should be addressed to DLA Land and Maritime, ATTN: VAC, P.O. Box 3990, Columbus, OH 43218-3990, or emailed to Semiconductor@dla.mil. Since contact information can change, you may want to verify the currency of this address information using the ASSIST Online database at https://assist.dla.mil/.

AMSC N/A

FSC 5961

* 1.4 Primary electrical characteristics at T_C = +25°C.

Type	Min $V_{(BR)DSS}$ V_{GS} = 0 I_D = 1.0 mA dc	$V_{GS(TH)1}$ $V_{DS} \geq V_{GS}$ I_D = 1.0 mA dc		Max I_{DSS1} V_{GS} = 0 V_{DS} = 80 percent of rated V_{DS}	Max $r_{DS(ON)}$ (1) V_{GS} = 12 V dc		E_{AS} at I_{D1}	I_{AS}
					T_J = +25°C at I_{D2}	T_J = +150°C at I_{D2}		
	V dc	V dc		µA dc	ohm	ohm	mJ	A
		Min	Max					
2N7431U, U2L, U2S	60	2.0	4.0	25	0.015	0.036	500	75.0
2N7432U, U2L, U2S	100	2.0	4.0	25	0.040	0.100	500	51.0
2N7433U, U2L, U2S	200	2.0	4.0	25	0.070	0.175	500	43.0

(1) Pulsed (see 4.5.1).

* 1.5 Part or Identifying Number (PIN). The PIN is in accordance with MIL-PRF-19500, and as specified herein. See 6.4 for PIN construction example and 6.5 for a list of available PINs.

* 1.5.1 JAN certification mark and quality level for encapsulated devices. The quality level designators for encapsulated devices that are applicable for this specification sheet from the lowest to the highest level are as follows: “JANTXV” and "JANS".

* 1.5.2 Radiation hardness assurance (RHA) designator. The RHA levels that are applicable for this specification sheet from lowest to highest are as follows: "R", “F”, “G”, and "H".

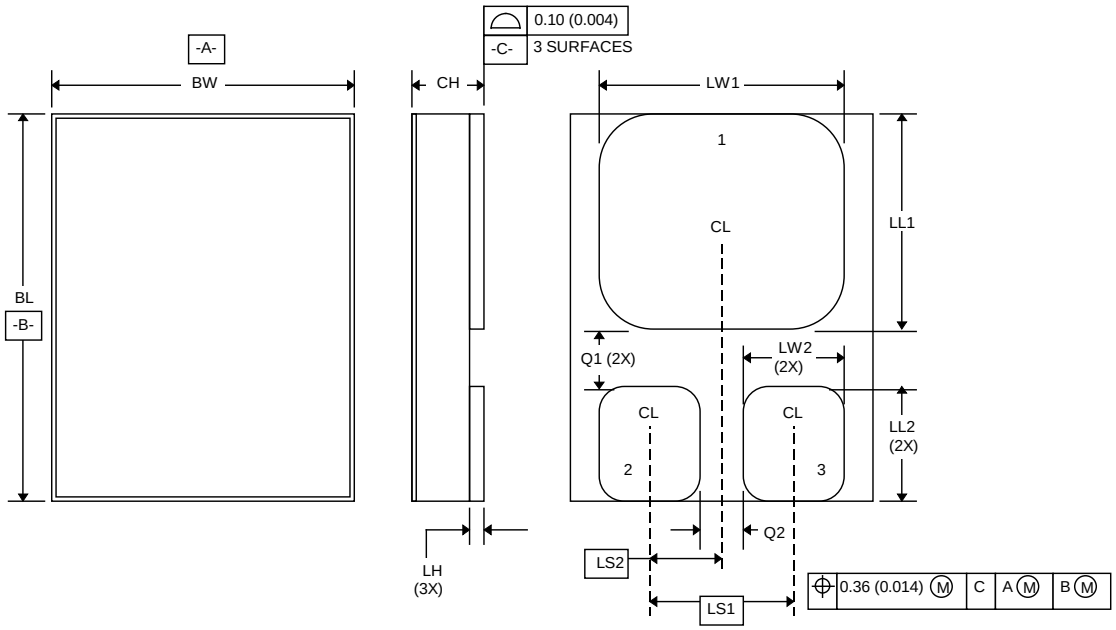
* 1.5.3 Device type. The designation system for the device types of transistors covered by this specification sheet are as follows.

* 1.5.3.1 First number and first letter symbols. The transistors of this specification sheet use the first number and letter symbols "2N".

* 1.5.3.2 Second number symbols. The second number symbol for the transistors covered by this specification sheet is as follows: "7431", “7432”, and “7433”.

* 1.5.3.3 Suffix letters. The suffix letter "U" (in lieu of "U2") are used on devices that are packaged in the SMD2 TO-276AC package of figure 1. The suffix letters "U2L" are used on devices that are packaged in the SMD2 TO-276AC package and have additional flat leads added, see figure 2. The suffix letters "U2S" are used on devices that are packaged in the SMD2 TO-276AC package mounted to a carrier board, see figure 3.

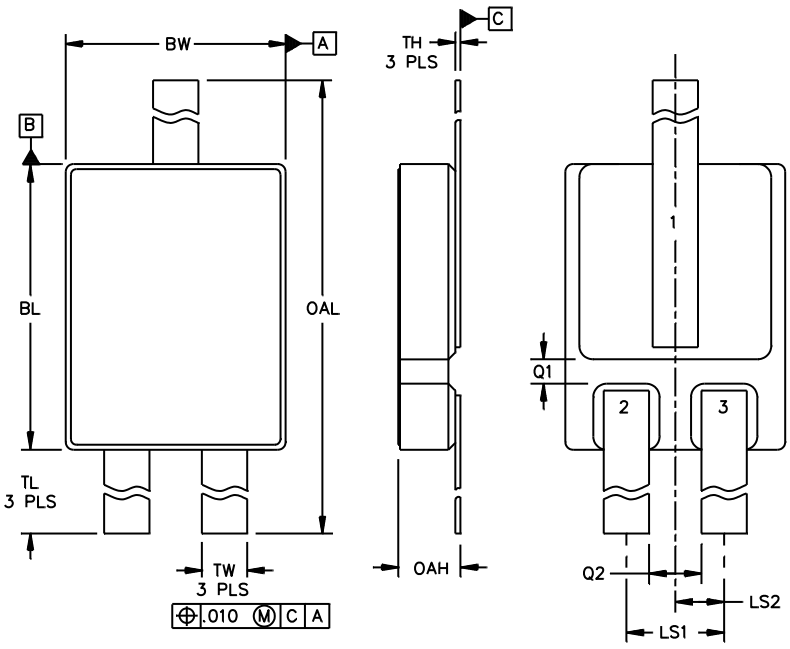
* 1.5.4 Lead finish. The lead finishes applicable to this specification sheet are listed on QPDSIS-19500.



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.685	.695	17.40	17.65
BW	.520	.530	13.21	13.46
CH		.142		3.60
LH	.010	.020	0.26	0.50
LW1	.435	.445	11.05	11.30
LW2	.135	.146	3.43	3.71
LL1	.470	.480	11.94	12.19
LL2	.152	.162	3.86	4.12
LS1	.240 BSC		6.10 BSC	
LS2	.120 BSC		3.05 BSC	
Q1	.035		0.89	
Q2	.050		1.27	
Term 1	Drain			
Term 2	Gate			
Term 3	Source			

Notes:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. The lid shall be electrically isolated from the drain, gate and source.
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.
* 5. This suffix "U" for this package was assigned before the "U2" was assigned to the SMD-2 package used in other slash sheets.

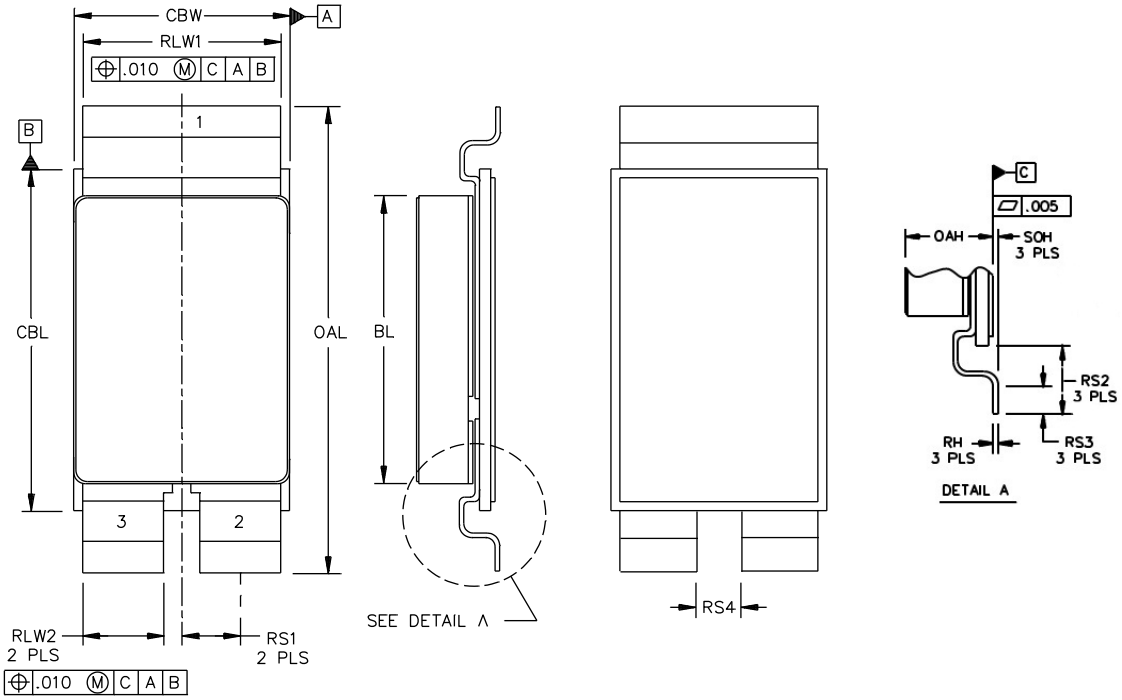
* FIGURE 1. Physical dimensions for SMD-2 (surface mount package).



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.685	.695	17.40	17.65
BW	.520	.530	13.21	13.46
LS1	.240 BSC		6.10 BSC	
LS2	.120 BSC		3.05 BSC	
Q1	.035		0.89	
Q2	.050		1.27	
TH	.005	.007	0.127	0.177
TL	.650	.675	16.52	17.14
TW	.095	.105	2.42	2.66
OAH		.150		3.81
OAL	1.985	2.045	50.42	51.94
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. The lid shall be electrically isolated from the drain, gate and source.
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 2. Physical dimensions, U2 with leaded option (U2L).



Symbol	Dimensions			
	Inches		Millimeters	
	Min	Max	Min	Max
BL	.685	.695	17.40	17.65
CBL	.825	.840	20.96	21.34
CBW	.520	.535	13.21	13.59
OAH	.174	.204	4.42	5.18
OAL	1.109	1.144	28.17	29.06
RH	.009	.015	0.23	0.38
RLW1	.473	.497	12.01	12.62
RLW2	.178	.202	4.52	5.13
RS1	.1475 BSC		3.75 BSC	
RS2	.142	.152	3.61	3.86
RS3	.045	.055	1.14	1.40
RS4	.093		2.36	
SOH	.005	.015	0.13	0.38
TERM 1	Drain			
TERM 2	Gate			
TERM 3	Source			

NOTES:
1. Dimensions are in inches.
2. Millimeters are given for general information only.
3. The lid shall be electrically isolated from the drain, gate and source.
4. In accordance with ASME Y14.5M, diameters are equivalent to ϕx symbology.

* FIGURE 3. Physical dimensions, U2 with carrier board option (U2S).

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3 and 4 of this specification. This section does not include documents cited in other sections of this specification or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of documents cited in sections 3 and 4 of this specification, whether or not they are listed.

2.2 Government documents.

2.2.1 Specifications, standards, and handbooks. The following specifications, standards, and handbooks form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-PRF-19500 - Semiconductor Devices, General Specification for

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-750 - Test Methods for Semiconductor Devices

(Copies of these documents are available online at http://quicksearch.dla.mil/.)

2.3 Order of precedence. Unless otherwise noted herein or in the contract, in the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. REQUIREMENTS

3.1 General. The individual item requirements shall be as specified in MIL-PRF-19500 and as modified herein.

3.2 Qualification. Devices furnished under this specification shall be products that are manufactured by a manufacturer authorized by the qualifying activity for listing on the applicable qualified manufacturer's list (QML) before contract award (see 4.2 and 6.3).

3.3 Abbreviations, symbols, and definitions. Abbreviations, symbols, and definitions used herein shall be as specified in MIL-PRF-19500 and as follows:

I_{AS} ..... Rated avalanche current, nonrepetitive
nC ..... nano Coulomb.

* 3.4 Interface and physical dimensions. The interface and physical dimensions shall be as specified in MIL-PRF-19500 and on figure 1, figure 2 (U2L, surface mount TO-276AC with additional flat leads added) and figure 3 (U2S, surface mount TO-276AC with additional flat leads added and mounted to a carrier board) herein. Methods used for electrical isolation of the terminals shall employ materials that contain a minimum of 90 percent Al_2O_3 (ceramic).

3.4.1 Terminal material and finish. Terminal material shall be copper-tungsten. Terminal finish shall be solderable as defined in MIL-PRF-19500, MIL-STD-750, and herein. Where a choice of terminal finish is desired, it shall be specified in the acquisition document (see 6.2).

3.4.2 Internal construction. Multiple chip construction is not be permitted to meet the requirements of this specification.

* 3.4.3 Lead attach or Carrier package. Alternations to the device shall be performed on devices that have passed all screening and QCI required per MIL-PRF-19500 and listed herein. When leads or carrier attach is added to the U (U2) package, as a minimum, the vendor shall perform the tests specified in 4.3.4 herein.

3.5 Electrical performance characteristics. Unless otherwise specified herein, the electrical performance characteristics are as specified in paragraph 1.3, 1.4 and table I.

3.6 Electrical test requirements. The electrical test requirements shall be as specified in table I.

3.7 Electrostatic discharge protection. The devices covered by this specification require electrostatic discharge protection.

3.7.1 Handling. MOS devices must be handled with certain precautions to avoid damage due to the accumulation of static charge. However, the following handling practices are recommended.

a. Devices should be handled on benches with conductive handling devices.

b. Ground test equipment, tools, and personnel handling devices.

c. Do not handle devices by the leads.

d. Store devices in conductive foam or carriers.

e. Avoid use of plastic, rubber, or silk in MOS areas.

f. Maintain relative humidity above 50 percent if practical.

g. Care should be exercised during test and troubleshooting to apply not more than maximum rated voltage to any lead.

h. Gate must be terminated to source, $R \leq 100\ k\Omega$, whenever bias voltage is to be applied drain to source.

* 3.8 Marking. Marking shall be in accordance with MIL-PRF-19500. At the option of the manufacturer, marking may be omitted from the body, but shall be retained on the initial container. Devices that have been altered with lead or carrier attached per the specification herein shall have the altered part number on the device or on the device packaging.

3.9 Workmanship. Semiconductor devices shall be processed in such a manner as to be uniform in quality and shall be free from other defects that will affect life, serviceability, or appearance.

4. VERIFICATION

4.1 Classification of inspections. The inspection requirements specified herein are classified as follows:

a. Qualification inspection (see 4.2).

b. Screening (see 4.3).

c. Conformance inspection (see 4.4 and tables I and II).

4.2 Qualification inspection. Qualification inspection shall be in accordance with MIL-PRF-19500.

* 4.2.1 Group E qualification. Group E inspection shall be performed for qualification or re-qualification only. In case qualification was awarded to a prior revision of the specification sheet that did not request the performance of table III (or table IV, as applicable) tests, the tests specified in table III (or table IV, as applicable) herein that were not performed in the prior revision shall be performed on the first inspection lot of this revision to maintain qualification.

4.2.1.1 Single event effects (SEE). SEE shall be performed at initial qualification and after process or design changes which may affect radiation hardness (see table III and table V). Upon qualification, manufacturers shall provide the verification test conditions from section 5 of method 1080 of MIL-STD-750 that were used to qualify the device for inclusion into section 6 of the slash sheet. End-point measurements shall be in accordance with table II. SEE characterization data shall be made available upon request of the qualifying or acquiring activity.

* 4.2.1.2 Lead or carrier attach. For devices that include a lead or carrier attach package configuration qualification shall be performed in accordance with table IV herein, at initial qualification and after process or design changes.

4.3 Screening (JANS and JANTXV levels only). Screening shall be in accordance with table E-IV of MIL-PRF-19500 and as specified herein. The following measurements shall be made in accordance with table I herein. Devices that exceed the limits of table I herein shall not be acceptable.

Screen (see table E-IV of MIL-PRF-19500) (1) (2)	Measurement	
	JANS level	JANTXV levels
(3)	Gate stress test (see 4.3.1)	Gate stress test (see 4.3.1)
(3)	Method 3470 of MIL-STD-750, E_{AS} test (see 4.3.2)	Method 3470 of MIL-STD-750, E_{AS} test (see 4.3.2)
(3) 3c	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)	Method 3161 of MIL-STD-750, thermal impedance (see 4.3.3)
9	Subgroup 2 of table I herein. I_{DSS1}, I_{GSSF1}, I_{GSSR1},	Not applicable
10	Method 1042 of MIL-STD-750, test condition B	Method 1042 of MIL-STD-750, test condition B
11	I_{GSSF1}, I_{GSSR1}, I_{DSS1}, $r_{DS(on)1}$, $V_{GS(TH)1}$ Subgroup 2 of table I herein. ΔI_{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater.	I_{GSSF1}, I_{GSSR1}, I_{DSS1}, $r_{DS(on)1}$, $V_{GS(TH)1}$ Subgroup 2 of table I herein.
12	Method 1042 of MIL-STD-750, test condition A	Method 1042 of MIL-STD-750, test condition A
13	Subgroups 2 and 3 of table I herein. ΔI_{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater. $\Delta r_{DS(on)1}$ = ±20 percent of initial value $\Delta V_{GS(th)1}$ = ±20 percent of initial value	Subgroup 2 of table I herein. ΔI_{GSSF1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{GSSR1} = ±20 nA dc or ±100 percent of initial value, whichever is greater. ΔI_{DSS1} = ±10 μA dc or ±100 percent of initial value, whichever is greater. $\Delta r_{DS(on)1}$ = ±20 percent of initial value $\Delta V_{GS(th)1}$ = ±20 percent of initial value

(1) At the end of the test program, I_{GSSF1}, I_{GSSR1}, and I_{DSS1} are measured.
* (2) An out-of-family program to characterize I_{GSSF1}, I_{GSSR1}, I_{DSS1}, $V_{GS(th)1}$, and $r_{DS(on)1}$ shall be invoked.
(3) Shall be performed anytime after temperature cycling, screen 3a; JANTXV level does not need to be repeated in screening requirements.

4.3.1 Gate stress test. Apply V_{GS} = 30 V minimum for t = 250 μs minimum.

4.3.2 Single pulse avalanche energy E_{AS}.

a. Peak current (I_{AS}) ..... $I_{AS} = I_{D1}$.

b. Peak gate voltage (V_{GS})..... 12 V.

c. Gate to source resistor (R_{GS})..... $25\Omega \leq R_{GS} \leq 200\Omega$.

d. Initial case temperature (T_C) ..... +25°C +10°C, -5°C.

e. Inductance..... $\left[\frac{2E_{AS}}{(I_{D1})^2}\right]\left[\frac{V_{BR}-V_{DD}}{V_{BR}}\right]$ mHminimum

f. Number of pulses to be applied..... 1 pulse minimum.

g. Supply voltage (V_{DD}) ..... 25 V (50 V for 2N7433).

* 4.3.3 Thermal impedance. The thermal impedance measurements shall be performed in accordance with method 3161 of MIL-STD-750 using the guidelines in that method for determining I_M, I_H, t_H, t_{SW}, (and V_H where appropriate). See table III, group E, subgroup 4 herein.

* 4.3.4 Lead or carrier attach screening (All quality levels). All surface mount devices with added leads or carrier boards shall be screened as specified herein.

Screen	MIL-STD-750 Method	Conditions
1. Hermetic Seal 1/ a. Fine Leak b. Gross Leak	1071	
2. Thermal Response (see 4.3.3) A2 dc Electrical 2/ 3/	3161	Read and Record.
3. X-Radiography	2076	The solder material coverage at the package lead pad/SMD carrier sub interfaces shall be 85% minimum
4. External Visual Examination	2071	Cracks or separation of materials shall not be evident on any device after the SMD lead attach assembly operation. Pad and Isolation areas shall be free from foreign matter and extraneous solder. Solder filet coverage at the lead/package lead pad interfaces, along all visible sides, minimum of 75% solder fillet coverage.
5a. Physical dimensions	2066	6 piece sample, each device shall meet the requirements specified on figures 2 and 3.
5b. Terminal Strength	2036	3 piece sample.

1/ Evaluation of surface sorption in accordance with method 1071 shall be performed.
2/ Only DC electrical test specified herein.
3/ When lead carrier bend is requested, the electrical test is performed prior to the bend process

4.4 Conformance inspection. Conformance inspection shall be in accordance with MIL-PRF-19500, and as specified herein.

4.4.1 Group A inspection. Group A inspection shall be conducted in accordance with table E-V of MIL-PRF-19500 and table I herein. End-point electrical measurements shall be in accordance with table I, subgroup 2 herein.

* 4.4.2 Group B inspection. Group B inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VIA (JANS) and table E-VIB (JANTXV) of MIL-PRF-19500, and herein.

* 4.4.2.1 Quality level JANS, table E-VIA of MIL-PRF-19500.

	Subgroup	Method	Condition
	B3	1051	Test condition G, 100 cycles.
	B3	2075	See 3.4.2.
	B3	2077	SEM qualification may be performed anytime prior to lot formation.
*	B4	1042	Intermittent operation life, condition D. No heat sink or forced air cooling on the device shall be permitted during the on cycle; t_{on} = 30 seconds minimum.
	B5	1042	Accelerated steady-state gate bias, condition B, V_{GS} = rated, T_A = +175°C, t = 24 hours minimum.
	B5	1042	Accelerated steady-state reverse bias, condition A, V_{DS} = rated, T_A = +175°C, t =120 hours minimum.

* 4.4.2.2 Quality level JANTXV, table E-VIB of MIL-PRF-19500.

	Subgroup	Method	Condition
	B2	1051	Test condition G, 25 cycles.
*	B3	1042	Intermittent operation life, condition D. No heat sink or forced air cooling on the device shall be permitted during the on cycle; t_{on} = 30 seconds minimum.

* 4.4.3 Group C inspection. Group C inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-VII of MIL-PRF-19500 and as follows.

	Subgroup	Method	Condition
	C2	2036	Not applicable.
*	C5	3161	Thermal resistance, see 4.3.3, $R_{\theta JC(max)}$ = 0.42°C/W (U) or 10 ºC/W (U2L),1.50 ºC/W (U2S).
	C6	1042	Intermittent operation life, condition D. No heat sink or forced air cooling on the device shall be permitted during the on cycle; t_{on} = 30 seconds minimum.

4.4.4 Group D Inspection. Group D inspection shall be conducted in accordance with table E-VIII of MIL-PRF-19500 and table II herein.

* 4.4.5 Group E inspection. Group E inspection shall be conducted in accordance with the conditions specified for subgroup testing in table E-IX of MIL-PRF-19500 and as specified in table III and IV herein.

4.5 Methods of inspection. Methods of inspection shall be as specified in the appropriate tables and as follows.

4.5.1 Pulse measurements. Conditions for pulse measurement shall be as specified in section 4 of MIL-STD-750.

* TABLE I. Group A inspection.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 1						
Visual and mechanical inspection	2071					
Subgroup 2						
Thermal impedance 2/	3161	See 4.3.3	$Z_{\theta JC}$			°C/W
Breakdown voltage, drain to source	3407	V_{GS} = 0 V; I_D = 1 mA dc, bias condition C	$V_{(BR)DSS}$			
2N7431U, U2L, U2S				60		V dc
2N7432U, U2L, U2S				100		V dc
2N7433U, U2L, U2S				200		V dc
Gate to source voltage threshold	3403	$V_{DS} \geq V_{GS}$, I_D = 1 mA dc	$V_{GS(TH)1}$	2.0	4.0	V dc
Gate current	3411	V_{GS} = +20 V dc, bias condition C, V_{DS} = 0	I_{GSSF1}		+ 100	nA dc
Gate current	3411	V_{GS} = -20 V dc bias condition C, V_{DS} = 0	I_{GSSR1}		-100	nA dc
Drain current	3413	V_{GS} = 0 V dc, bias condition C, V_{DS} = 80 percent of rated V_{DS}	I_{DSS1}		25	µA dc
Static drain to source on-state resistance	3421	V_{GS} = 12 V dc, condition A, pulsed (see 4.5.1), I_D = I_{D2}	$r_{DS(on)1}$			
2N7431U, U2L, U2S					0.015	ohm
2N7432U, U2L, U2S					0.040	ohm
2N7433U, U2L, U2S					0.070	ohm
Static drain to source on-state resistance	3421	V_{GS} = 12 V dc, condition A pulsed (see 4.5.1), I_D = I_{D1}	$r_{DS(on)2}$			
2N7431U, U2L, U2S					0.018	ohm
2N7432U, U2L, U2S					0.045	ohm
2N7433U, U2L, U2S					0.077	ohm
Forward voltage	4011	Pulsed (see 4.5.1), bias condition A, I_D = I_{D1}, V_{GS} = 0 V dc	V_{SD}			
2N7431U, U2L, U2S					1.5	V dc
2N7432U, U2L, U2S					1.8	V dc
2N7433U, U2L, U2S					1.8	V dc

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 3						
High temperature operation:		$T_C = T_J = +125°C$				
Gate current	3411	V_{GS} = +20 and -20 V dc, bias condition C, V_{DS} = 0	I_{GSS2}		± 200	nA dc
Drain current	3413	V_{GS} = 0 V; bias condition C, V_{DS} = 80 percent of rated V_{DS}	I_{DSS2}		0.25	mA dc
Static drain to source on-state resistance	3421	V_{GS} = 12 V dc, pulsed (see 4.5.1), $I_D = I_{D2}$	$r_{DS(on)3}$			
2N7431U, U2L, U2S					0.030	ohm
2N7432U, U2L, U2S					0.085	ohm
2N7433U, U2L, U2S					0.140	ohm
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, I_D = 1 mA dc	$V_{GS(TH)2}$	1.0		V dc
Low temperature operation:		$T_C = T_J = -55°C$				
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$, I_D = 1 mA dc	$V_{GS(TH)3}$		5.0	V dc
Subgroup 4						
Forward transconductance	3475	I_D = rated I_{D2}, V_{DD} = 15 V (see 4.5.1)	g_{FS}			
2N7431U, U2L, U2S				18.0		S
2N7432U, U2L, U2S				16.0		S
2N7433U, U2L, U2S				9.0		S
Switching time test	3472	$I_D = I_{D1}$, V_{GS} = 12 V dc, R_G = 2.35Ω, V_{DD} = 50 percent of rated V_{DS}				
Turn-on delay time			$t_{d(on)}$			
2N7431U, U2L, U2S					27	ns
2N7432U, U2L, U2S					35	ns
2N7433U, U2L, U2S					50	ns
Rise time			t_r			
2N7431U, U2L, U2S					120	ns
2N7432U, U2L, U2S					150	ns
2N7433U, U2L, U2S					200	ns
Turn-off delay time			$t_{d(off)}$			
2N7431U, U2L, U2S					120	ns
2N7432U, U2L, U2S					150	ns
2N7433U, U2L, U2S					200	ns

See footnotes at end of table.

* TABLE I. Group A inspection - Continued.

Inspection 1/	MIL-STD-750		Symbol	Limits		Unit
	Method	Conditions		Min	Max	
Subgroup 4 - Continued						
Fall time			t_f			
2N7431U, U2L, U2S					100	ns
2N7432U, U2L, U2S					130	ns
2N7433U, U2L, U2S					130	ns
Subgroup 5						
Safe operating area test (high voltage)	3474	See figures 6, 7, and 8 t_p = 10 ms minimum, V_{DS} = 80 percent of maximum rated V_{DS}, ($V_{DS} \leq 200$)				
Electrical measurements		See table I, subgroup 2				
Subgroup 6						
Not applicable						
Subgroup 7						
Gate charge	3471	Condition B				
On-state gate charge			$Q_{g(on)}$			
2N7431U, U2L, U2S					270	nC
2N7432U, U2L, U2S					310	nC
2N7433U, U2L, U2S					290	nC
Gate to source charge			Q_{gs}			
2N7431U, U2L, U2S					60	nC
2N7432U, U2L, U2S					53	nC
2N7433U, U2L, U2S					42	nC
Gate to drain charge			Q_{gd}			
2N7431U, U2L, U2S					110	nC
2N7432U, U2L, U2S					110	nC
2N7433U, U2L, U2S					120	nC
Reverse recovery time	3473	di/dt ≤ 100 A/µs, $V_{DD} \leq 50$ V, $I_D = I_{D1}$	t_{rr}			
2N7431U, U2L, U2S					360	ns
2N7432U, U2L, U2S					520	ns
2N7433U, U2L, U2S					820	ns

1/ For sampling plan, see MIL-PRF-19500.
2/ This test required for the following end-point measurements only:
Group B, subgroups 2 and 3 (JANTXV).
Group B, subgroups 3 and 4 (JANS).
Group C, subgroup 2 and 6.
Group E, subgroup 1.

* TABLE II. Group D inspection.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Preirradiation limits				Postirradiation limits				Unit
	Method	Conditions		R		F, G and H 5/		R		F, G and H 5/		
				Min	Max	Min	Max	Min	Max	Min	Max	
Subgroup 1												
Not applicable												
Subgroup 2		T_C = +25°C										
Steady-state total dose irradiation (V_{GS} bias) 4/	1019	V_{GS} = 12V, V_{DS} = 0										
Steady-state total dose irradiation (V_{DS} bias) 4/	1019	V_{DS} = 80 percent of rated V_{DS} (pre-irradiation), VGS = 0										
Pre and post electricals:												
Breakdown voltage, drain to source	3407	V_{GS} = 0, I_D = 1 mA, bias cond. C	V_{BRDSS}									
2N7431U, U2L, U2S				60		60		60		60		V dc
2N7432U, U2L, U2S				100		100		100		100		V dc
2N7433U, U2L, U2S				200		200		200		200		V dc
Gate to source voltage (threshold)	3403	$V_{DS} \geq V_{GS}$	$V_{GS(th)1}$									
2N7431U, U2L, U2S				2.0	4.0	2.0	4.0	2.0	4.0	1.25	4.5	V dc
2N7432U, U2L, U2S				2.0	4.0	2.0	4.0	2.0	4.0	1.25	4.5	V dc
2N7433U, U2L, U2S				2.0	4.0	2.0	4.0	2.0	4.0	1.25	4.5	V dc
Gate current	3411	V_{GS} = 20 V, V_{DS} = 0 bias cond. C	I_{GSSF1}		100		100		100		100	nA dc
Gate current	3411	V_{GS} = -20 V, V_{DS} = 0, bias cond. C	I_{GSSR1}		-100		-100		-100		-100	nA dc
Drain current	3413	V_{GS} = 0, bias cond. C, V_{DS} = 80 percent of rated V_{DS} (pre-irradiation)	I_{DSS1}		25		25		25		50	µA dc

See footnotes at end of table.

* TABLE II. Group D inspection - Continued.

Inspection 1/ 2/ 3/	MIL-STD-750		Symbol	Preirradiation limits				Postirradiation limits				Unit
	Method	Conditions		R		F, G and H 5/		R		F, G and H 5/		
				Min	Max	Min	Max	Min	Max	Min	Max	
Static drain to source on-state voltage	3405	V_{GS} = 12 V, cond. A, pulsed (see 4.5.1), $I_D = I_{D2}$	$V_{DS(on)1}$									
2N7431U, U2L, U2S					0.840		0.840		0.840		1.400	V dc
2N7432U, U2L, U2S					1.300		1.300		1.300		1.852	V dc
2N7433U, U2L, U2S					1.890		1.890		1.890		2.970	V dc
Forward voltage source to drain diode	4011	V_{GS} = 0, $I_D = I_{D1}$, bias condition A	V_{SD}									
2N7431U, U2L, U2S					1.5		1.5		1.5		1.5	V dc
2N7432U, U2L, U2S					1.8		1.8		1.8		1.8	V dc
2N7433U, U2L, U2S					1.8		1.8		1.8		1.8	V dc

1/ For sampling plan, see MIL-PRF-19500.
2/ Group D qualification may be performed anytime prior to lot formation. Wafers qualified to these group D, QCI requirements may be used for any other specification utilizing the same die design.
3/ At the manufacturer's option, group D samples need not be subjected to the screening tests, and may be assembled in its qualified package or in any qualified package that the manufacturer has data to correlate the performance to the designated package.
4/ Separate samples shall be pulled for each bias.
5/ The "H" designation represents devices which pass end-points at the G, R, and F designated Total-Ionizing-Dose (TID).

TABLE III. Group E inspection (all quality levels) for qualification or re-qualification only.

Inspection	MIL-STD-750		Sample plan
	Method	Conditions	
Subgroup 1			45 devices c = 0
Temperature cycling	1051	Test condition G, 500 cycles.	
Hermetic seal	1071		
Fine leak Gross leak			
Electrical measurements		See table I, subgroup 2.	
Subgroup 2 1/			45 devices c = 0
Steady-state reverse bias	1042	Condition A, 1,000 hours.	
Electrical measurements		See table I, subgroup 2.	
Steady-state gate bias	1042	Condition B, 1,000 hours.	
Electrical measurements		See table I, subgroup 2.	
Subgroup 4			Sample size N/A
Thermal impedance curves		See MIL-PRF-19500.	
Subgroup 10			22 devices c = 0
Commutating diode for safe operating area test procedure for measuring dv/dt during reverse recovery of power MOSFET transistors or insulated gate bipolar transistors	3476	Test conditions shall be derived by the manufacturer	
Subgroup 11			3 devices
SEE 2/ 3/	1080	See MIL-STD-750 method 1080 and 6.2.	

1/ A separate sample for each test shall be pulled.
2/ Group E qualification of SEE effect testing may be performed prior to lot formation. Qualification may be extended to other specification sheets utilizing the same structurally identical die design.
3/ Device qualification to a higher level LET is sufficient to qualify all lower level LETs.

* TABLE IV. Lead alternation Qualification inspection requirements.

Inspections 1/	MIL-STD-750		Sample size
	Method	Conditions	
Subgroup 1			6 devices, c = 0
Temperature cycle	1051	100 Temp cycles, test condition G or maximum storage temperature.	
Hermetic seal	1071		
Fine leak Gross leak			
A2 dc electrical		Read and record.	
Thermal response	3161		
External visual examination	2071	Cracks or separation of materials shall not be evident on test samples.	
Subgroup 2			6 devices, c = 0
Intermittent operating life	1042	Condition D; 6,000 cycles.	
A2 dc electrical		Read and record.	
Thermal response	3161		
External visual examination	2071	Cracks or separation of materials shall not be evident on test samples.	
Subgroup 3			6 devices, c = 0
Terminal strength	2036	Tension; Condition A 10lbs for 10 seconds Fatigue; Condition E 3 arcs of 90 +/_5 degrees each 8.0 oz.	
A2 dc electrical		Read and record.	
External visual examination	2071	Cracks or separation of materials shall not be evident on test samples.	

1/ Qualification samples performed on non-formed leaded devices.

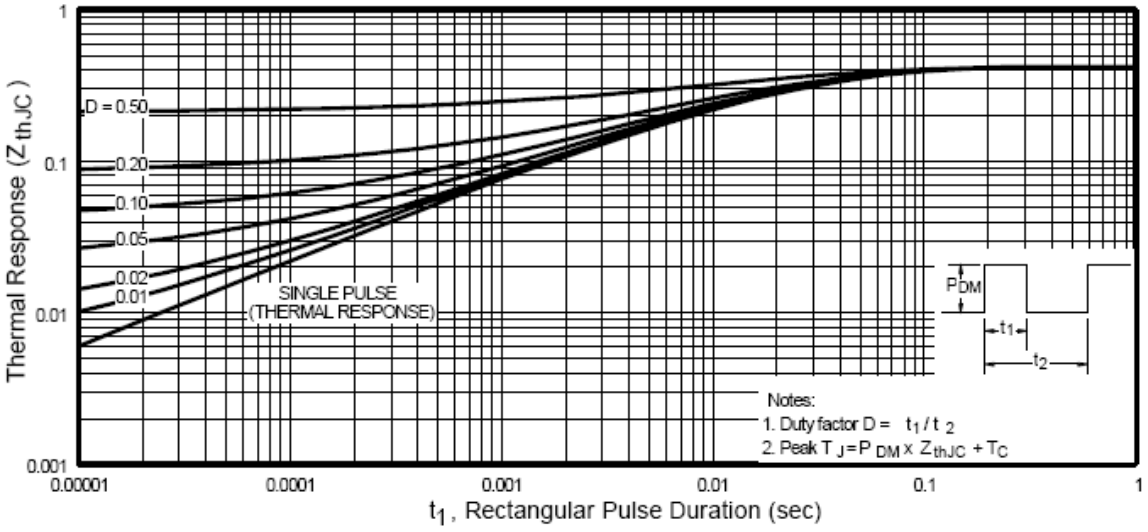
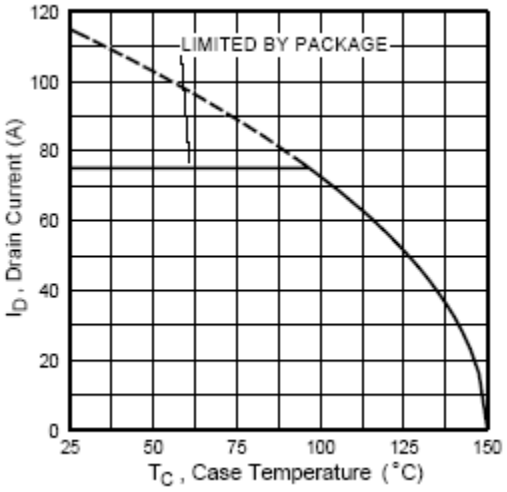
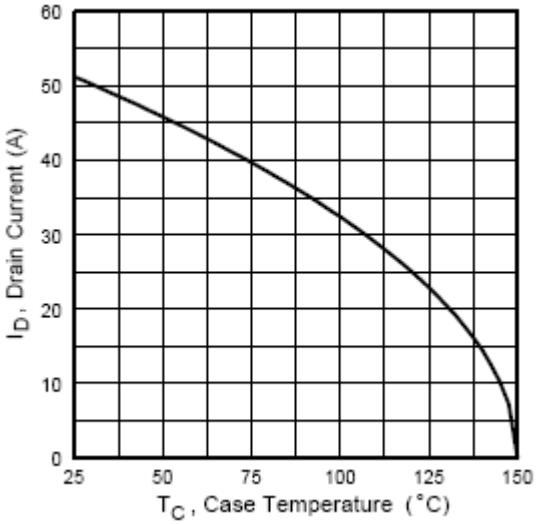


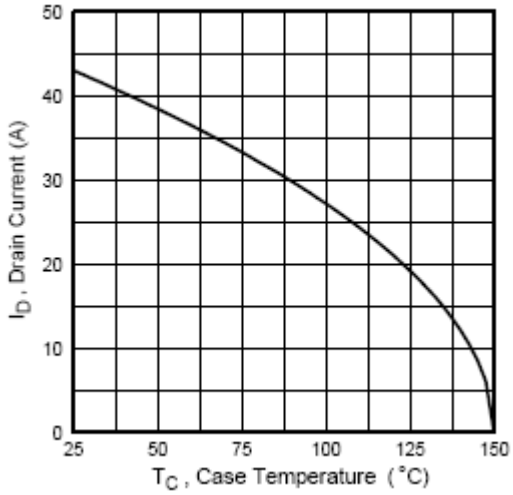
FIGURE 4. Thermal impedance curve.



2N7431U, U2L, U2S

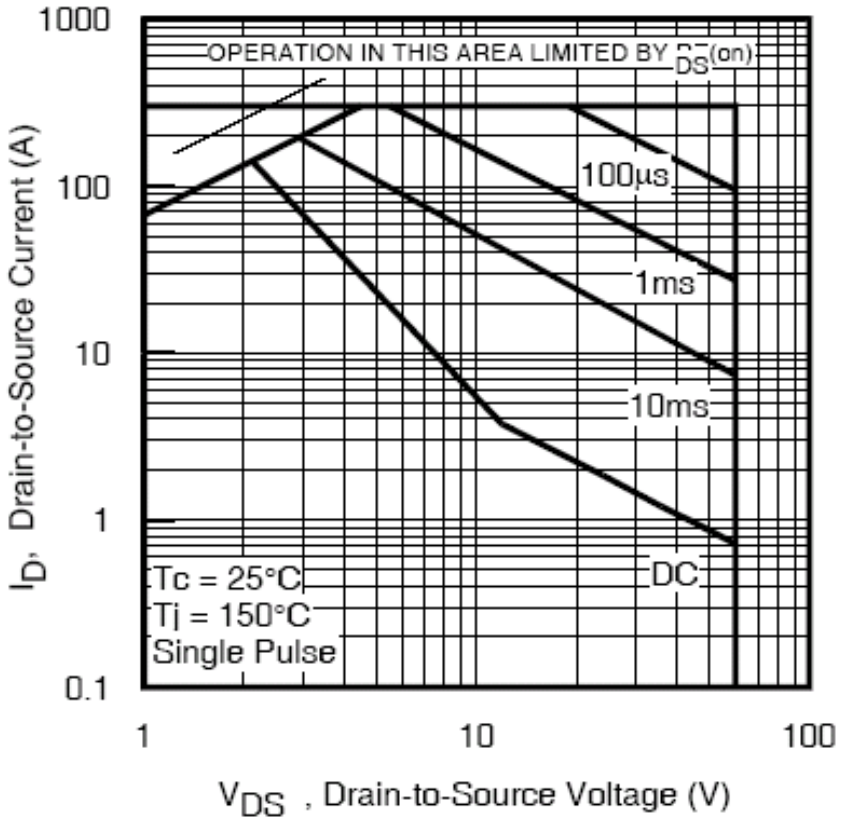


2N7432U, U2L, U2S

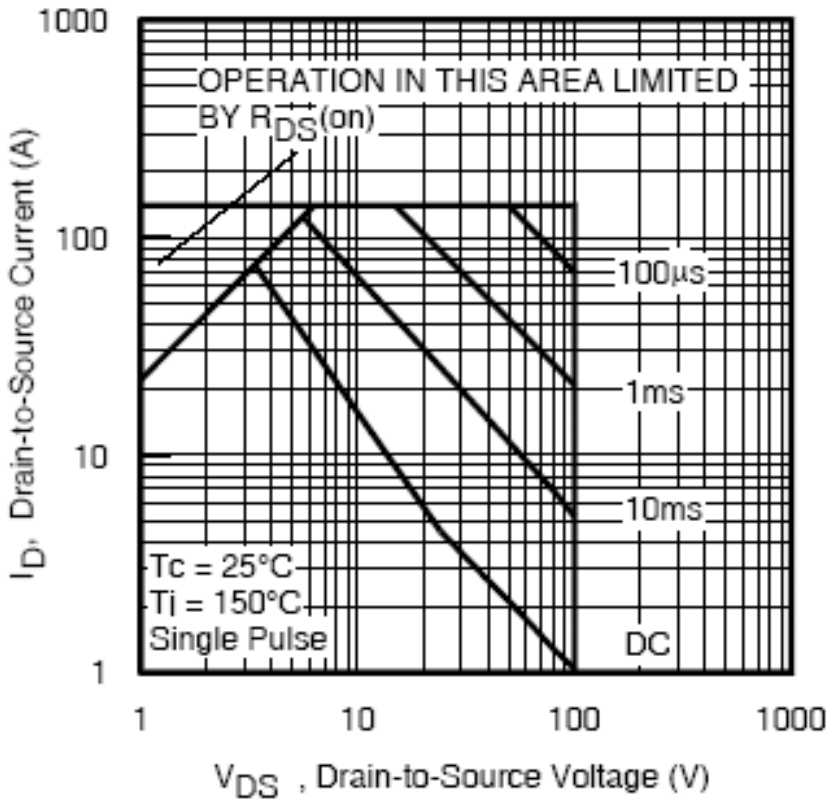


2N7433U, U2L, U2S

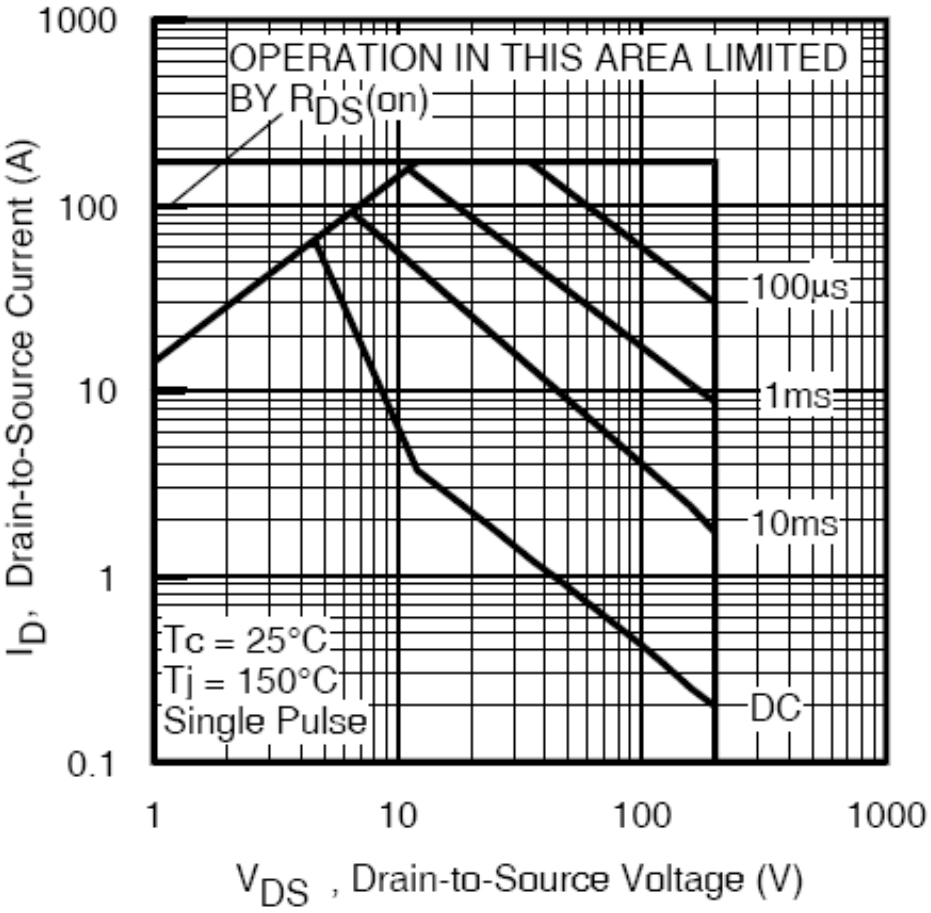
* FIGURE 5. Maximum drain current vs case temperature graphs.



* FIGURE 6. Safe operating area graph for 2N7431U, U2L, U2S.



* FIGURE 7. Safe operating area graph for 2N7432U, U2L, U2S.



* FIGURE 8. Safe operating area graph for 2N7433U, U2L, U2S.

5. PACKAGING

5.1 Packaging. For acquisition purposes, the packaging requirements shall be as specified in the contract or order (see 6.2). When packaging of materiel is to be performed by DoD or in-house contractor personnel, these personnel need to contact the responsible packaging activity to ascertain packaging requirements. Packaging requirements are maintained by the Inventory Control Point's packaging activities within the Military Service or Defense Agency, or within the Military Service's system commands. Packaging data retrieval is available from the managing Military Department's or Defense Agency's automated packaging files, CD-ROM products, or by contacting the responsible packaging activity.

6. NOTES

(This section contains information of a general or explanatory nature that may be helpful, but is not mandatory. The notes specified in MIL-PRF-19500 are applicable to this specification.)

6.1 Intended use. Semiconductors conforming to this specification are intended for original equipment design applications and logistic support of existing equipment.

6.2 Acquisition requirements. Acquisition documents should specify the following:

a. Title, number, and date of this specification.

b. Packaging requirements (see 5.1).

c. Terminal material and finish (see 3.4.1).

d. Product assurance level and type designator.

e. For acquisition of RHA designated devices, table II, subgroup 1 testing of group D herein is optional. If subgroup 1 is desired, it should be specified in the contract.

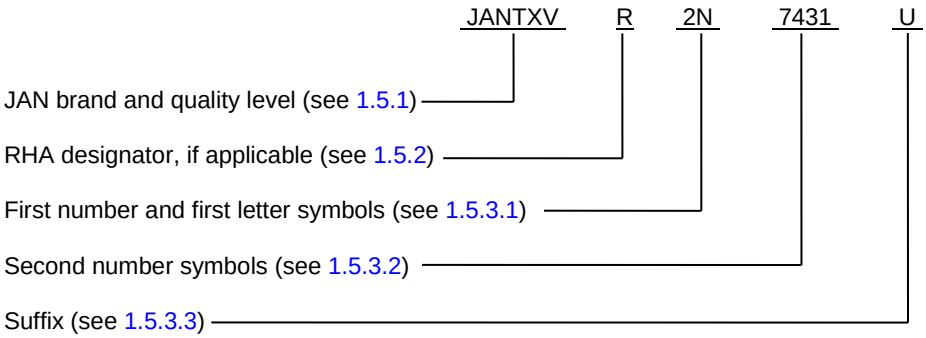
f. If specific SEE characterization conditions are desired (see section 6.8 and table V), manufacturer's cage code should be specified in the contract or order.

g. If SEE testing data is desired, it should be specified in the contract or order.

* h. If the leaded or carrier board configuration is desired for U suffix devices (see 3.4.3), it should be specified in the contract. For acquisition of U suffix devices, the default configuration is delivered without the carrier board.

6.3 Qualification. With respect to products requiring qualification, awards will be made only for products which are, at the time of award of contract, qualified for inclusion in Qualified Manufacturers List (QML 19500) whether or not such products have actually been so listed by that date. The attention of the contractors is called to these requirements, and manufacturers are urged to arrange to have the products that they propose to offer to the Federal Government tested for qualification in order that they may be eligible to be awarded contracts or orders for the products covered by this specification. Information pertaining to qualification of products may be obtained from DLA Land and Maritime, ATTN: VQE, P.O. Box 3990, Columbus, OH 43218-3990 or e-mail vqe.chief@dla.mil. An online listing of products qualified to this specification may be found in the Qualified Products Database (QPD) at https://assist.dla.mil.

* 6.4 PIN construction example. The PINs for encapsulated devices are constructed using the following form.



* 6.5 List of PINs. The following is a list of possible PINs available on this specification sheet.

PINs for devices of the "TXV" quality level	PINs for devices of the "TXV" quality level with RHA (1)	PINs for devices of the "S" quality level	PINs for devices of the "S" quality level with RHA (1)
JANTXV2N7431U	JANTXV#2N7431U	JANS2N7431U	JANS#2N7431U
JANTXV2N7431U2L	JANTXV#2N7431U2L	JANS2N7431U2L	JANS#2N7431U2L
JANTXV2N7431U2S	JANTXV#2N7431U2S	JANS2N7431U2S	JANS#2N7431U2S
JANTXV2N7432U	JANTXV#2N7432U	JANS2N7432U	JANS#2N7432U
JANTXV2N7432U2L	JANTXV#2N7432U2L	JANS2N7432U2L	JANS#2N7432U2L
JANTXV2N7432U2S	JANTXV#2N7432U2S	JANS2N7432U2S	JANS#2N7432U2S
JANTXV2N7433U	JANTXV#2N7433U	JANS2N7433U	JANS#2N7433U
JANTXV2N7433U2L	JANTXV#2N7433U2L	JANS2N7433U2L	JANS#2N7433U2L
JANTXV2N7433U2S	JANTXV#2N7433U2S	JANS2N7433U2S	JANS#2N7433U2S

(1) The number sign (#) represents one of four RHA designators available (R, F, G, or H).

6.6 Substitution information. Devices covered by this specification are substitutable for the manufacturer's and user's Part or Identifying Number (PIN). This information in no way implies that manufacturer's PIN's are suitable for the military PIN.

Preferred types Military PIN	Commercial PIN (1)
2N7431U 2N7432U 2N7433U	IRHNA_064 IRHNA_160 IRHNA_260

(1) IRHNA7: 100k RAD (Si)
IRHNA3: 300k RAD (Si)
IRHNA4: 600k RAD (Si)
IRHNA8: 1000k RAD (Si)

* 6.7 JANHC and JANKC die versions. The JANHC and JANKC die versions of these devices are covered under specification sheet MIL-PRF-19500/657.

6.8 Application data.

6.8.1 Manufacturer specific irradiation data. Each manufacturer qualified to this slash sheet has characterized its devices to the requirements of MIL-STD-750 method 1080 and as specified herein. Since each manufacturer's characterization conditions can be different and can vary by the version of method 1080 qualified to, the MIL-STD-750 method 1080 revision version date and conditions used by each manufacturer for characterization have been listed here (see table V) for information only. SEE conditions and figures listed in section 6 are current as of the date of this specification sheet, please contact the manufacturer for the most recent conditions.

TABLE V. Manufacturers characterization conditions.

Manufactures cage	Inspection	MIL-STD-750		Sample plan
		Method	Conditions	
No manufacturers are currently qualified to the SEE requirements	SEE 1/ Electrical measurements	1080	See MIL-STD-750E method 1080 I_{GSSF1}, I_{GSSR1}, and I_{DSS1} in accordance with table I, subgroup 2	3 devices
	Electrical measurements		I_{GSSF1}, I_{GSSR1}, and I_{DSS1} in accordance with table I, subgroup 2	
Upon qualification, all manufacturers will provide the verification test conditions to be added to this table.				

1/ I_{GSSF1}, I_{GSSR1}, and I_{DSS1} was examined before and following SEE irradiation to determine acceptability for each bias condition. Other test conditions in accordance with table I, subgroup 2, may be performed at the manufacturer's option.

* 6.9 Request for new types and configurations. Requests for new device types or configurations for inclusions in this specification sheet should be submitted to: DLA Land and Maritime, ATTN: VAC, Post Office Box 3990, Columbus, OH 43218-3990 or by electronic mail at Semiconductor@dla.mil or by facsimile (614) 693-1642 or DSN 850-6939.

6.10 Changes from previous issue. The margins of this specification are marked with asterisks to indicate where changes from the previous issue were made. This was done as a convenience only and the Government assumes no liability whatsoever for any inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations and relationship to the last previous issue.

Custodians:
Army - CR
Navy - EC
Air Force - 85
NASA - NA
DLA - CC

Preparing activity:
DLA - CC

(Project 5961-2016-059)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, you should verify the currency of the information above using the ASSIST Online database at https://assist.dla.mil/.